FROM THE DIRECTORS´ CHAIRS

*Unni Steinsmo, SINTEF's president – CEO*
*Torbjørn Digernes, NTNU's rector*

# Energetic twins in a global society

Some of Europe's foremost research and technology communities are found in Trondheim. As "twin" institutions, NTNU and SINTEF are rooted in central Norway, but our ambitions extend far beyond Norway's borders, as we strive to be internationally outstanding. An important strategic tool to achieve this goal is to strengthen each other through international cooperation.

Billions of new citizens will join us around the "global dinner table".

Europe is making rapid progress towards establishing a European Research Area (ERA). NTNU and SINTEF are deeply involved in Europe's numerous research and innovation initiatives. It is our ambition to continue with this involvement in the years to come by making substantial contributions to the ERA, particularly in Horizon 2020, Joint Programming Initiatives, European Innovation Partnerships, the Strategic Energy Technology Plan and the European Energy Research Alliance.

Sustainable energy is an area of special importance for NTNU and SINTEF. The Strategic Energy Technology Plan lays out ambitious goals for Europe.

Sustainable energy is essential to human life. We need it to provide for our fundamental needs, such as food, clothing, housing, shelter, transportation, health and recreation. The international community must collectively make substantial cuts in the current levels of greenhouse gas emissions. At the same time, billions of new citizens will join us around the "global dinner table". Providing sufficient clean energy to ensure a peaceful and sustainable society for everybody in the future is one of the greatest challenges facing global society today. There will be an enormous demand for new knowledge, new technology, new solutions and innovations to meet this global challenge.

Together, NTNU and SINTEF are among Europe's leading climate and energy research communities. We play an active role in supplying the scientific and technological information and innovations that are essential to the global transformation process needed to achieve a sustainable future. In all, more than 1200 researchers at NTNU and SINTEF are engaged in work that will result in new knowledge, new technology and new solutions to realize our common vision: sufficient clean energy for a sustainable and peaceful global society.

## Tasty medicine

Many of us have problems swallowing tablets or capsules, particularly if they taste bad. The worst is for children or the elderly.

Researchers at NTNU have previously developed the technology needed to manufacture cod liver oil and omega 3 as chewable tablets. Now, in cooperation with a pharmaceutical company, the researchers have taken this approach a step further. The idea is to encapsulate bad-tasting medicine in a tasty and chewable "pillow" of alginate and gelatine (biopolymers), from which the bad medicine taste can't escape until the pill is safely in the patient's stomach. The use of different types of polymers allows researchers to control the speed of the medicine's release. The first medicines produced using this approach are expected to be on the market in the next couple of years.

## Corals changed by $CO_2$

Norwegian corals have changed their appearance and structure over the last hundred years. That's what scientists at the NTNU Museum of Natural History and Archaeology found when they compared specimens from the museum's coral collection, which has been assembled over several generations.

Researchers think that the changes can be explained by a more acidic ocean – which is due to an increase in the amount of $CO_2$ being absorbed by the ocean compared to past decades.

# Safer use of nanoparticles

What sort of HSE knowledge do we really need to deal with the new substances that are now found in everything from clothes to cosmetics and electronics? Can nanomaterials damage the environment, or are these invisible particles safer than we tend to believe? These are among the questions that SINTEF scientist Andy Booth wants to answer. He has taken the initiative to launch a new competence transfer project – SafeNano Norway – on health, safety and environmental aspects of nanotechnology. Traditionally, there has been little close cooperation between the disciplines of HSE and nanotechnology, but the real need for such collaboration has recently become clear.

Photo: Thor Nielsen

## New ultrasonic method reveals strokes and cancers

An NTNU/SINTEF research group believes that it has created ultrasonic images that are so clear that they make it easier to identify strokes and different types of cancer. Until now, one of the main problems with ultrasonic imaging has been the amount of noise in the images, which is due to reverberation or multiple echoes. The new way of creating ultrasonic images (SURF imaging) uses a transducer that transmits two sets of sound waves rather than one: a low-frequency wave-form that manipulates its high-frequency equivalent, which in turn is used to create the actual image.

## Preemies at risk of mental difficulties

Low birth weight babies have an increased risk of mental difficulties when they are adults, a study conducted at NTNU has shown. The study included normal birth weight children, children born at term but with a low birth weight, and premature babies with quite low birth weights.

Babies in the first group had less than a one-in-ten chance of suffering from mental disorders 20 years later. The risk for children in the second group was one in five, while among the premature babies the risk of having a diagnosed mental disorder was one in three. Anxiety disorders and ADHD were the most common diagnoses.

Photo: photos.com

## Commercialization of LedaFlow

Kongsberg Oil & Gas Technologies (KOGT) has just launched its LedaFlow multiphase simulator on the petroleum industry market. The simulator is the result of an eight-year-long collaboration with SINTEF, Total and ConocoPhillips, which KOGT has further developed into a commercial product. LedaFlow offers significantly improved functionality, flexibility and accuracy in flow simulations. These improvements mean that the simulator can both reduce risks and improve the operating performance of petroleum installations. LedaFlow also provides improved resolution in modelling, offering better, more accurate simulations of multiphase flow than existing products.

Photo: Morguefile

## Look out for low-frequency vehicle noise

If you often become tired when you are driving, the culprit may be noise, and in many cases, "audible" noise may be the most dangerous. The acoustic environment inside a car is often dominated by extremely low-frequency noise, and Truls Gjestland, a senior scientist at SINTEF, says that such sounds can be tiring. Even sounds made up of frequencies that are so low that they are not perceived directly by our ears (so-called "infrasound") also tend to make us drowsy.

## Norway as a "green battery"?

A government-appointed committee in Germany wants to make the country's electricity sources renewable by using the Norwegian hydropower network as a "battery."

The Germans want Norway to pour electricity from hydropower into the grid in northern Europe when winds are calm and wind turbines are still - and when electricity demands are low, to use a surplus of cheap wind power to pump water back into Norwegian hydro reservoirs again.

In Norway, this would require the construction of what are called pump power stations. These would have a turbine that can be used as a pump, which could also be reversed to produce electricity. Cedren, the Centre for the Environmental Design of Renewable Energy, one of eight Norwegian national research centres for environmentally friendly energy, is studying what is needed to realize the large-scale development of these pump power stations.

Photo: photos.com

## Nordic master's degree in seafood

The Nordic Council of Ministers has given its support to a new Nordic master's programme in seafood quality, which will encompass production, processing and distribution.

The programme is being developed by a consortium with participants from Iceland, Sweden, Denmark and Norway. NTNU and the Norwegian University of Life Sciences are the Norwegian representatives to this group.

# The United States arms most dicta torships

China is often accused of supporting totalitarian regimes in Africa. But the United States arms far more African dictatorships than China does.

**GLOBALIZATION** **POLITICS • ECONOMICS**

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The Chinese are about to change Africa. In January, a survey conducted by the Financial Times showed that over the last two years, China has lent more money to developing countries than the World Bank.

Trade between China and Africa has increased dramatically in the last ten years, and in 2009 the Chinese were Africa's largest trading partner. In 1950 the trade volume between the two countries was USD 12 million. In 2010 that figure had ballooned to USD 115 billion.

And while Barack Obama is struggling hard to get the American economy back on track, China's economy is growing strongly. Indra de Soysa, a professor of political science and director of NTNU's Globalization Programme, predicts that in 20 years, the Chinese economy will be larger than the US economy.

Photo: Scanpix

**GUNS TO AFRICA:** While the US uses arms to advance its strategic interests, the Chinese are most interested in profits.

**FOLLOW THE ARMS FLOW** • "Journalists, academics and politicians in the West express fear that a dictatorship like China will come to have such a dominant position in the world's economy. Many think that the Chinese have no morals, and that they do not care about worker protection, human rights and democratic conditions in the country where they trade," says de Soysa.

To determine if this was true, de Soysa, along with Professor Paul Midford from NTNU, followed the export of weapons from China and the United States to African dictatorships from 1989 to 2006, using figures from the Stockholm Institute for Peace Research.

"If a nation sells or gives away weapons to a country, this is a sign that the countries are looking for a more long-term relationship," said de Soysa, who has now documented that the US arms far more African dictators than China.

And if that isn't enough: The figures also show that Americans clearly prefer dictatorships, such as Equatorial Guinea and Djibouti, while the Chinese clearly prefer democratic regimes, as Zambia and Namibia.

**STRATEGY VERSUS PROFIT** • "I was very surprised by the findings. There is this international image of China as the enemy, like the big bad wolf that sucks out the resources from its trading partners without worrying about how people feel. People think that because China is a dictatorship, the country will try to sell weapons to other dictatorships, and that the US will do the opposite. But the USA looks to promote its strategic interests, even if it means supporting dictatorial regimes, while China is primarily looking to make money," de Soysa says.

De Soysa thinks that the fear of China's entry into the world economy is partly due to its silencing of political protesters, such as Nobel Prize winner Liu Xiaobo. China's sale of arms to dictatorial regimes such as Sudan and Zimbabwe, from 1990 to 2008, also sparked anger from Western human rights activists who claimed that China was undermining the development of democratic rights in Africa.

Anne Sliper Midling

# A water pulk from the rubbish dump

With a simple water pulk or transporter, children in Haiti will have more time for schooling.

**WATER** **DESIGN • CHILDREN • INTERNATIONAL AID**

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"We want poor people to be able to make our water pulk out of materials that they have lying around," says Olav Fåsetbru Kildal.

Kildal is an architecture student at NTNU and the brains behind the water pulk, which has now seen the light of day as a result of "Experts in Teamwork", a collaborative problem-solving course that all master's students at NTNU must take.

Kildal got the idea for the water pulk when he was in Haiti and saw children carrying large buckets of water on their heads every day, often over long distances. Water buckets are given out by aid organizations, and usually can hold 10-14 litres.

The daily weight causes great stress on young bones, muscles and joints. According to several aid organizations, children in many developing countries use so much time to transport water that it reduces their time for schooling.

Pulling the water behind them would be much easier, Kildal thought.

**A TRIP TO THE DUMP** • When Kildal was in Haiti at Eastertime, he took a trip to the garbage dump to see if his idea could be implemented. After fifteen minutes his water pulk was ready.

"There are a lot of hoses and rebar lying around after the earthquake. The rebar can easily be bent into a pole. So I used glue and some wooden blocks to attach the pole to the container. An old tire works well to protect the container. The only downside is glue. But it is possible to make glue of local materials," says Kildal.

Once Kildal and his fellow students got their grades, however, they had to put their idea for the water pulk on ice.

"We don't have enough resources to follow up on our work. We have planted the idea, and now we'll see if anyone uses it," says Kildal.

Anne Sanders Midling

Photo: Olav Fåsetbru Kildal

**WATER PULK:** An aluminium rod is bent around the neck of the water container. The container's flat side is covered by a piece cut from a larger container. A wooden block is glued to the bottom where the other rod is attached through a hole. Bits of a rubber mat from a car are glued around the container to prevent stones in the road from making holes in the tank.





# Gene therapy for ears

Gene therapy may someday in the future replace the use of implants in deaf people. The carrier for this gene medicine may be derived from shrimp shells.

**MEDICINE** **BIOTECHNOLOGY • CHITOSAN**

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Normal hearing depends on the presence of healthy hair cells in the inner ear. Gene therapy has the potential to slow the loss of hair cells and promote the growth of hair cells that have already been damaged.

In gene therapy, genetic material – DNA or RNA – is transported by a carrier to cells to provide instructions for and replace damaged genes. The carrier must protect its genetic package and help it make its way through the membranes that protect cells and their surroundings. The carrier should also be able to transport the genetic material right to the cells that need help.

For the first time ever, chitosan nanoparticles have been used as a carrier for gene therapy in the ear. Chitosan is produced from shrimp shells.

"Gene therapy may someday be an alternative to using surgery to implant CI, cochlear implants, in the deaf and hard of hearing," says Sabina Strand, at NTNU's Department of Biotechnology.

**BASIC RESEARCH PROMISING** • Strand studies the use of chitosan in gene therapy, and conducted this basic research, now ended, in cooperation with the Karolinska Institutet in Sweden. Here, researchers attempted to use chitosan as a carrier to deliver drugs and genes to the inner ear in guinea pigs. Chitosan was able to deliver drugs through the membrane that covers the tiny gap between the middle ear and inner ear. Chitosan was also able to deliver genes to the hair cells. Whether or not the results from guinea pigs can be transferred to human ears remains uncertain.

"However, chitosan is non-toxic and is not harmful to cells. Chitosan is therefore better than other carriers and has characteristics that mean it could potentially be used with patients," says Strand.

**TIDY PACKAGES** • Chitosan is produced from powdered shrimp shells. Acid removes salts, minerals and calcium carbonate. Strong alkalis and heat remove proteins. What remains is chitosan.

Extremely small nanoparticles in the range of 50-200 nm (nanometres) are formed spontaneously when the positively charged chitosan and negatively charged genes are mixed. Chitosan does a good job packaging up DNA and RNA's relatively large molecules.

**TAILORED THERAPY** • In the body, chitosan attaches itself to molecules, cells and membranes. When the nanoparticles have passed through a membrane, chitosan packages up the gene molecules so they return to their normal size again. Chitosan also creates gaps between cells, which facilitate the absorption of medicine.

Different forms of gene therapy require nanoparticles with different properties. The properties of nanoparticles are controlled by the way in which researchers tailor the chitosan structure, its molecular size and 3D architecture. But whether or not researchers will find the perfect mix of medicines for our ears and hair cells remains to be seen – and heard.

Siv Ingrid Skau Ekra

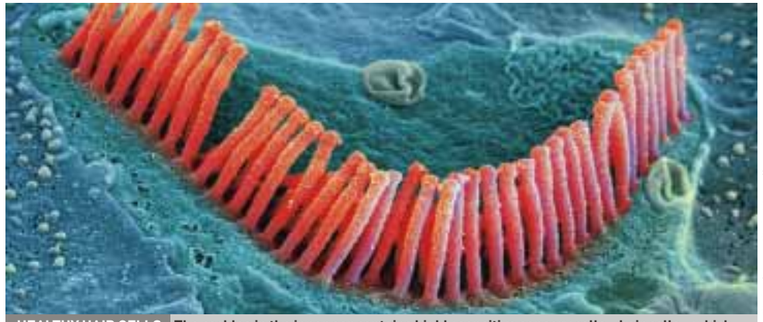
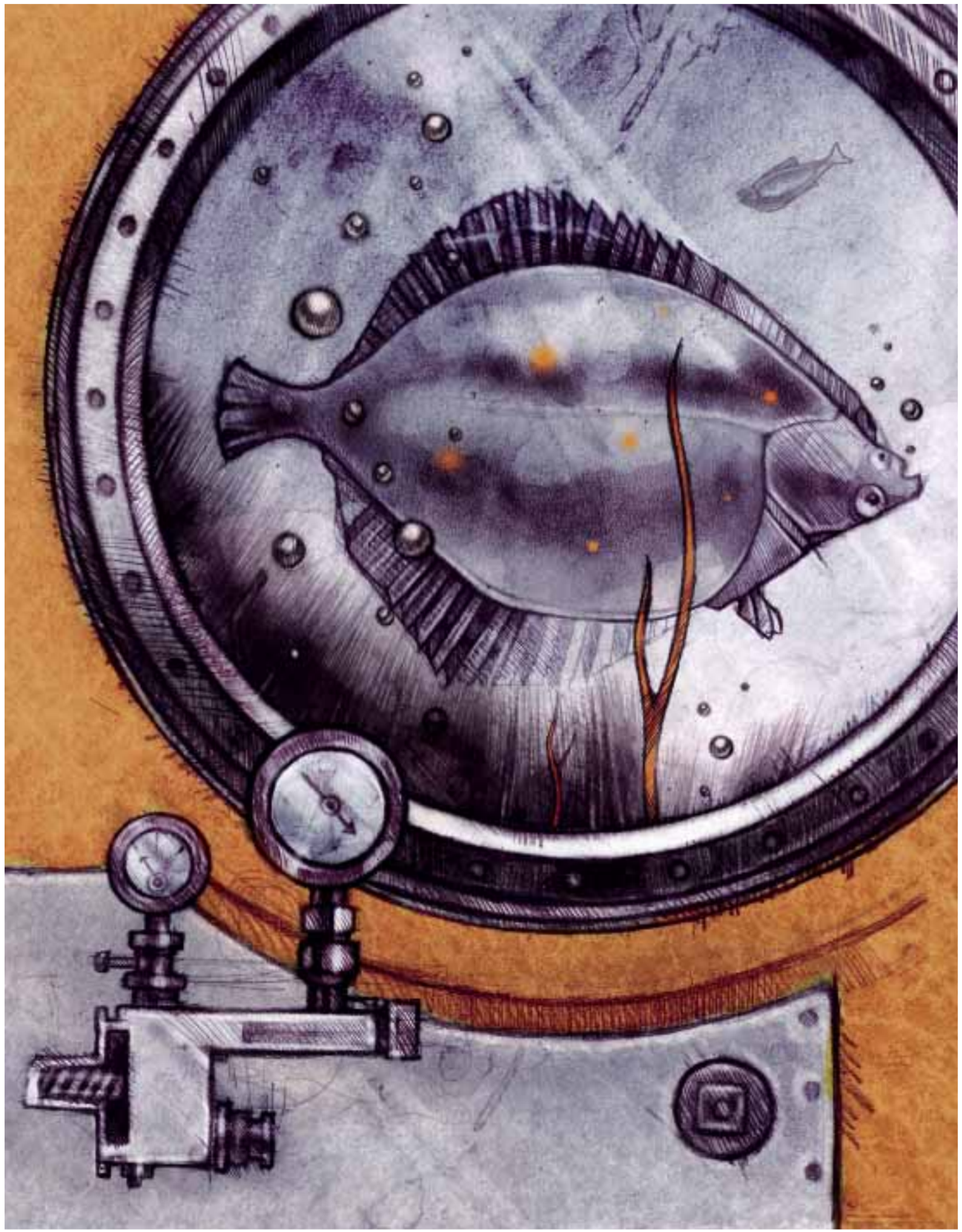


Photo: Science Photo Library/Scanpix

**HEALTHY HAIR CELLS:** The cochlea in the inner ear contains highly sensitive sensory cells – hair cells – which move in conjunction with fluctuations in volume. If the hair cells are damaged, a person's hearing is damaged.

Illustration: Line Halsnes



It is all well and good to store $CO_2$ under the seabed. But what if the $CO_2$ starts to leak?

# A flounder in fizzy water

**$CO_2$ STORAGE** **BIOLOGY • PRESSURE TANK**

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First, build a pressure tank.
Then add some corals and a flounder.
Add seawater and $CO_2$ gas.
Wait for about half a year.

This is the recipe to find out what happens to marine life if there is a $CO_2$ leak from undersea storage reservoirs.

**AN UNDERSEA EXPERIMENTAL REACTOR** • Tick. Tick. Psss. Tick. Tick. Psss. There's something ticking. And blowing. And ticking again. Just like the sound of someone on a respirator.

We are located on Trondheim waterfront, where the winter's cold is creeping in through our clothes. At the dock is NTNU's research boat, Gunnerus, rocking in the waves. Inside, at the ocean laboratory in Brattøra, it is almost as cold as outside. That should come as no surprise, however, since the room we are in has been designed to reflect conditions on the seabed, 300 metres below the water's surface.

And there, it is cold, quiet and dark. And under high pressure.

To mimic this, scientists at NTNU and SINTEF have developed a large pressure vessel made of titanium. Inside the tank is a box of bottom sediments from Trondheim Fjord. The tank and its layer of bottom sediment will provide answers to what might happen if any of the millions of tonnes of $CO_2$ being pumped into geologic formations under the seafloor begin to seep out.

And this is where the ticking and the hissing come into play. Underneath the research boat, down on the dock, there's a hose in the ocean. It sucks up seawater, which enters the tank, circulates around, and then drains out again.

**GAS TO THE BOTTOM** • But before we go any further: What is Statoil, Norway's main oil company, doing out there in the North Sea? They're doing much more than just pumping up the oil and natural gas that make Norway among the richest countries in the world.

In fact, their efforts are the main reason for the tank and the box with the bottom sediment. Increased $CO_2$ in the atmosphere threatens our global climate, and to help save a feverish planet, huge amounts of $CO_2$ have been pumped into reservoirs underneath the sea. Instead of releasing the gas generated by oil straight into the air, it is being stored deep under the seabed. There are rock formations that can store $CO_2$, and keep it away from the atmosphere. The $CO_2$, which is a fluid under pressure, moves around a little, hovering a bit, but does not resurface.

It sounds both wonderful and terrifying. What happens if the rock suddenly fractures? Can the $CO_2$ cause it to explode? Might there suddenly be a huge explosion of $CO_2$ in the North Sea, like a giant fountain?

**BULGING CRUST** • Every year almost a million tonnes of $CO_2$ are being pumped into a geological formation under the seabed near the Sleipner gas field, on the Norwegian continental shelf. The same is happening at the Snøhvit gas field in northern Norway, and in the Sahara desert in Algeria.

Even if the liquid $CO_2$ does not escape, it can move. Statoil's measurements from the Sahara show that the Earth's crust was actually lifted one inch over six years.

Tore Torp is a Statoil consultant working on $CO_2$ storage and a self-appointed foster-father to the test pressure tank. He says that outside of the Tordis field in the North Sea, so much →

“We are now studying the **worst** possible scenario in the tank.”

Marine chemist Murat Van Ardelan

→ water was pumped down for a test that the rock at the bottom actually cracked.

“Much of the water came up as a nice, small fountain, like you might see in a park. We learned a lot from that, and it can’t happen now, because the rock above the liquid is at least 1000 metres thick. At Snøhvit, $CO_2$ is being stored 2400 metres below the seabed. We also monitor the liquid, mostly by the use of seismic tools,” says Torp. Seismic monitoring is when sound waves are reflected back to an instrument, which then makes an image that can be compared to a kind of sound X-ray.

**NOT JUST FROM OIL AND GAS** • Bjørn Berger, a Statoil adviser, said scientists can always see how the liquid $CO_2$ moves.

“We take a picture of the $CO_2$, put the pictures on top of each other, and look for changes. We create environment maps around all the installations, and our goal is always to prove that the liquid stays there,” says Berger.

He believes it is important to remember that $CO_2$ is also a gas that is produced by life itself.

“It’s really not a toxic gas, per se, but is poisonous if you are exposed to too much of it. There is natural leakage from the Earth, from volcanoes and also from under the sea, for example. The Aegean Sea naturally contains more $CO_2$ than other areas, so the marine life there is unique compared to other places,” says Berger.

But even if reservoir rocks stay intact, and scientists monitor the liquid $CO_2$, Statoil has still found it necessary to spend NOK 5 million to finance the pressure tank, because there remain unanswered questions. For example, what happens if the liquid $CO_2$ escapes through small holes in the seabed? That might be something that would not appear on any seismic scan, but that would just seep out with a constant little hissing sound.

Photo: Corbis

**Psss! Small leaks can be harder to detect than large ones. For this reason, researchers are studying whether $CO_2$ gas can change the chemistry of the sediment and water, and the composition of marine life on the sea bottom – in other words, whether $CO_2$ puts a special signature on the seabed.**

**A SIGNATURE ON THE OCEAN FLOOR** • One of the many researchers working on this issue is a marine chemist at NTNU named Murat Van Ardelan. He believes that it is far more difficult to detect small leaks than large ones.

“With small leaks, the fluid will first dissolve in the water. With large leaks, the liquid can rise up to the seabed and bubble – like bubbles in a bottle of mineral water. To detect small leaks, we have to look for how $CO_2$ changes marine chemistry and the creatures living at the bottom of the sea. Maybe $CO_2$ has a special signature when it escapes to the ocean floor? Perhaps some bacteria will bloom with an increase in $CO_2$, while others die?” says Van Ardelan.

Together with three master's students from NTNU, he has conducted two tests in the tank to facilitate the search for changes.

“Undersea storage is the most realistic solution we have right now to reduce the amount of $CO_2$ in the atmosphere. Critics say that even if undersea storage does reduce the problem in the atmosphere, there is a risk that part of the problem will just be shifted to local zones where marine animals, plankton and fish are living. I do not think it will, but we are now studying the worst possible scenario in the tank,” says Ardelan.

**AT LAST, THE FLOUNDER** • The planned sequence of studies in the tank is to start with chemical processes, then bacteria, then single-celled organisms, mussels and finally cold-water corals. But the last creature that will be subjected to testing in the tank is a flounder from which blood samples will be taken while it is inside the tank.

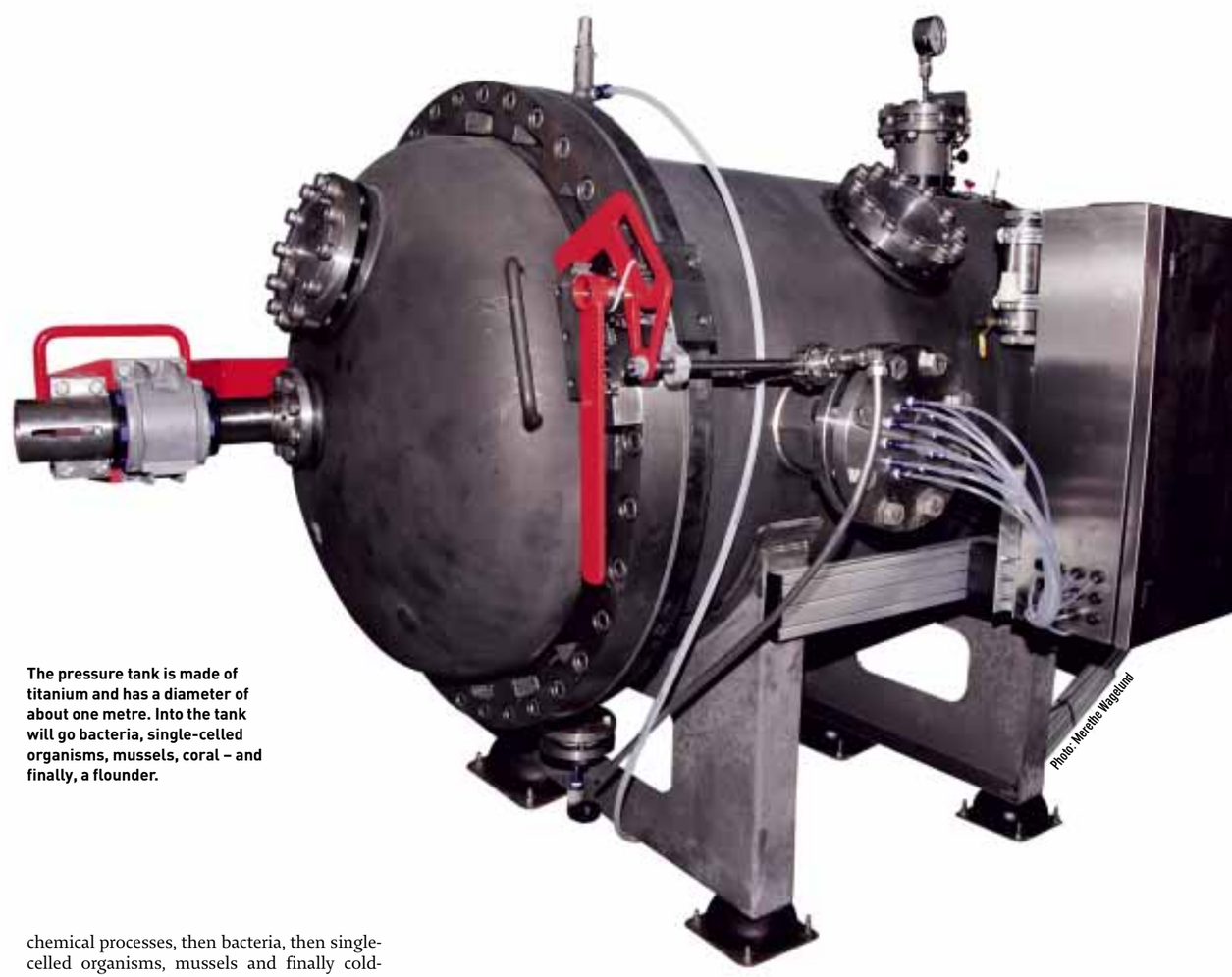

Photo: Merethe Wagelund

**The pressure tank is made of titanium and has a diameter of about one metre. Into the tank will go bacteria, single-celled organisms, mussels, coral – and finally, a flounder.**

But because the pressure in the tank simulates life at 300 metres beneath the sea, the fish will explode if it is removed directly from the tank. Because of this problem, the tank was built with kind of pressure lock where researchers using a robot arm can pick up the fish inside the tank, put it into the lock, gradually lower the pressure, and then test the fish.

“This has only been attempted in an open glass tank to date. This is the first time this research has been conducted under pressure, and over a longer period,” Torp says.

**THE ONLY THING WE KNOW FOR CERTAIN** • Tick. Tick. Psss. Tick. Tick. Psss.

It is time to stop the ticking of the tank. Kathrine Sundeng, Nina Gjøsund and Gøril Aasen Slindre have all written their master’s theses about work with the tank, and are in the first graduating class from NTNU’s “Environmental Toxicology and Chemistry” programme. It is they who have conducted most of the experiments.

The three students begin to empty the tank of water, and then will remove the box containing the sediment. Murat Van Ardelan rattles off a lot of unintelligible names of what all the bacteria are called, and what function they serve. Small bacteria can change the basic features of the ecosystem, he says.

“Although geophysicists say that the caprock can’t be cracked, we do not know that for certain. There could be leaks from old oil drilling holes or existing cracks. What will happens to seawater chemistry and marine life if there is a leak? The only thing we know for certain is that $CO_2$ will acidify the ocean,” says Ardelan. ■

**$CO_2$ STORAGE UNDER THE SEA**

- **Since 1996, the Norwegian oil and gas company Statoil has been storing $CO_2$ under the sea, after an suggestion from NTNU and SINTEF scientists. Between 13 to 14 million tonnes of $CO_2$ have been stored underneath the Sleipner gas field. Another 4 million tonnes have been stored in the Sahara, while 1 million tonnes have been injected at the Snøhvit gas field.**
- **According to $CO_2$GeoNet, which is the European network for the geological storage of $CO_2$, the capture and storage of $CO_2$ can contribute substantially to slowing human-induced climate change by 2050.**

# The archbishop's mint

The medieval coin workshop found in Trondheim is the world's best preserved. Now scientists have reconstructed the entire coin-making process.

**HISTORY** **ARCHAEOLOGY • NUMISMATICS**

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Photo: Nina Tveter/NTNU Info

A model of the coin workshop at the Archbishop's Palace, as it must have been around the year 1500.

Medieval Trondheim, early 1500s: A mint master and his apprentice have been up since the break of dawn. As the day drew to its end, they sat at a bench in the workshop, ready to strike coins.

They have already analysed the chemical composition of the silver items to be melted down and made into the coins. They have made the right coin alloy: 30 per cent silver and 70 per cent copper. They have cast rods, hammered them flat, cut them in pieces, and made the pieces round.

Then, after they were weighed, adjusted and dipped in an acid bath to make them shiny, the coins were ready for striking with the Archbishop's own dies.

For these were Archbishop Gaute Ivarsson's coins, which King Hans of Denmark, Norway and Sweden had given him the right to mint. The bishop was a man of great political and ecclesiastical power. He led the Norwegian Council of the Realm, and was an expert in increasing the Church's holdings in the country.

What neither the archbishop, coin master nor apprentice could know was that in only a few years the walls and benches would be demolished and the fine tile floor would be covered with mud – while another bishop will have built a new workshop on the remnants of the old.

They also could not know that there would be a third coin workshop atop the previous two -- and that more than 500 years later, the surface of the ground would lie several metres higher than their own workshop floor.

**THE PALACE IN FLAMES** • Trondheim, 18 August 1983: Dense smoke rose against the morning sky. The Archbishop's Palace – a cluster of unique buildings from the Middle Ages – was in flames! The Fire Department managed to rescue the 800-year-old stone buildings, but two storehouses from the 1700s were lost – and with them irreplaceable cultural treasures.

But nothing is so bad that some good cannot come out of it. For archaeologists, the fire was a golden opportunity to explore the medieval city of Trondheim, called Nidaros. Between 1991 and 1995 almost 5000 cubic metres of soil were turned over, and the number of finds was greater than anyone could have imagined, totalling roughly 63 000 objects.

The most sensational and unexpected discoveries were the mints – three separate workshops on top of each other in the layers of soil. The best preserved lay at the bottom, which turned out to have belonged to Archbishop Gaute Ivarsson. There was a large intact workshop from the early 1500s, with a checkerboard-patterned tile floor in red and yellow, a hearth, metal pieces, pieces of coins and finished coins.

"It was a unique discovery and is a world-class attraction, in line with the Viking ships," says numismatist Jon Anders Risvaag. "No other country can boast such an authentic coin workshop from the Middle Ages."

The workshop is located there still, just as it was found, and is now a part of the Archbishop's Palace. But it is only recently that historians and metallurgists at NTNU have estimated the extent of coin production at the workshop, and documented how the Archbishop's coins were actually minted.

**A MICRO-WORKSHOP** • "This was certainly both the world's northernmost and smallest coin workshop. In European terms, its production was microscopic: probably only about 60 000 coins a year," says Risvaag.

That may sound like more than just a little, but by the 1500s in Europe, coin production was essentially an industry: There were huge workshops with hundreds of employees, which spewed out millions of coins each year.

The Archbishop of Nidaros, on the other hand, was not allowed to have more than one coin master and one apprentice, the King had decided.

The estimate of 60 000 coins was based on two things: One was how many different kinds of imprints have been found stamped on different coins, and how many coins could be embossed with the top and bottom embossing dies before these would have to be replaced. Risvaag has done these calculations.

The second was based on what two men could produce in one year – if long workdays are factored in, but weekend days are not. Metallurgists made this calculation based on how long the complicated manufacturing process necessarily had to take.

"The fun is that each of our different approaches resulted in the same estimate," says Risvaag.

**THE ARCHBISHOP'S MEANS OF PAYMENT** • But if 60 000 coins a year amounted to almost nothing, even in little Norway, what was the point of minting them?

"The archbishop received the bulk of his income from the renting of farmlands and tithes. But minting itself was actually profitable," says Risvaag. "There was some income to be had from collecting old coins, which were purchased at a compulsory rate that was actually lower than the silver content in them was worth. Moreover, most fines to the church were paid in →

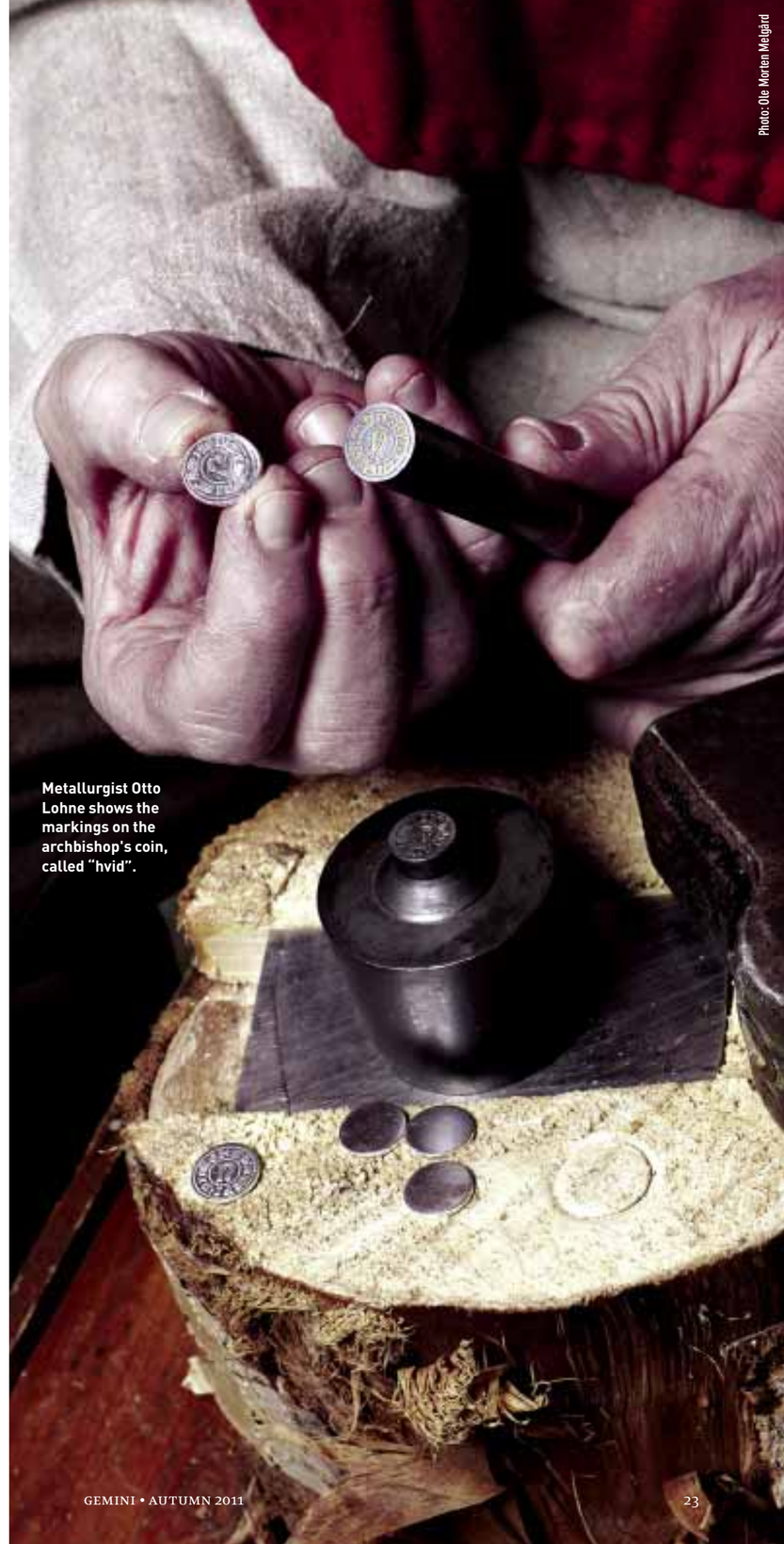


Photo: Ole Morten Melgård

Metallurgist Otto Lohne shows the markings on the archbishop's coin, called "hvid".

”A unique discovery and a
world-class attraction.”

Numismatist Jon Anders Risvaag

→ silver, so that could be used as the raw material with which to make coins. These payments were often in the form of small pieces that could not be used for larger purposes. And last but not least, the right to actually mint coins reinforced the importance of the archbishop's political power and rank in society.”

But the most important factor, Risvaag believes, was it was convenient for the archbishop to have a marketable form of payment when dealing with foreigners and farmers. “The right to mint coins that the archbishop had received from the king stated exactly what the silver content and weight had to be for Norwegian currency. So the Hanseatic League and the Dutch traders in Bergen knew exactly what a Norwegian hvid or penny or shilling was worth,” Risvaag said.

This theory is strengthened by the fact that there has not been a single archbishop's coin found in the city's medieval site from before the 1550s.

“Not one coin! The entire old town is as if it was vacuumed clean of coins, while there have been plenty of the archbishop's coins found in churches in rural areas, and some in Denmark and Sweden. This leads me to believe that Nidaros was mainly the production site for money that was to be used elsewhere. It also appears that the workshop was used for other metal work. Perhaps the archbishop made silver bars here that he used for trade,” suggests the historian.

**CELEBRATING A MILLENNIUM** • In a wardrobe at NTNU's Department of Materials Science and Engineering, metallurgists Otto Lohne and Pål Ulseth have some unusual garments. They were made for Trondheim's thousand-year anniversary in 1997. This was, in fact, when the two metallurgists were asked if they had anything professional to contribute to the celebration, something that could be interesting to watch.

Lohne thought immediately of coins, because he knew that Trondheim played an important role in the early production and use of coins in the realm, and he had also been involved with the chemical testing of coins from the archbishop's workshop. He and his colleague Ulseth had done research on how the money was made (see separate article), and had no objection to wearing medieval clothes to show the public how coins were minted in the Archbishop's Palace.

But the two researchers have only recently managed to reconstruct the whole process, from A to Z. Previously it was believed, for example, that the metal that was melted for coins was spread out on a plate and then stamped out, much like when you make flat cookies. But by using a microscope that shows the microstructure of the metal, researchers have now seen that the coins must have been cast in the form of a rod.

“We could also see that the rod could not have been cast in an iron form, but was cast either in soapstone or in sand,” explains Lohne.

The metallurgists have tested both metal pieces from the workshop and alloys they have created themselves, to figure out how the process worked. They have also tested all the production steps in their own laboratory.

One of the results of the research was that the exhibition around the old yard had to be changed. Not all of the text was accurate after the metallurgists became involved, and not all the objects were in the right place or were described correctly.

“To find the original bits and pieces and put them together into a coherent process has never been done before us. But we had the advantage of the archaeologists' previous work,” says Lohne.

**NIDAROS FIRST AND LAST** • Norway's coin history began in 995 when King Olav Tryggvason minted the first Norwegian pennies with his name. Ever since then, the right to mint coins has belonged to the king. In 1222, the archbishops were entitled to mint coins in the king's name, “as long as they were God and the kingdom's friends.”

This privilege was withdrawn in 1281, after a conflict between the archbishop and the king. There was a period when the king minted coins in Oslo, but between 1387 and 1483 there were definitely no coins minted in Norway.

The archbishops were eager to regain the right to mint coins, and in 1483 an agreement between King Hans and the Norwegian Council of the Realm stated that coins could be minted in Bergen, Oslo and Nidaros, in accordance with the ancient privilege accorded to the Nidaros Cathedral.

But a review of Norwegian coins and dies that have been identified from the period suggests that coins were probably not minted in Oslo at the time, nor were many minted in Bergen. Coins that were marked Moneta Norwei were not made in Oslo, as scientists previously believed, but at the Archbishop's Palace in Nidaros. Almost all Norwegian coins from the early 1500s until the Reformation in 1537 were struck in the three small workshops here.

The right to mint coins was, in principle, the king's and coins were marked with his name. But the last three Archbishops of Nidaros, Gaute Ivarsson, Erik Valkendorf and Olav Engelbrektsson, also marked coins with "archbishop" and their own symbols.

“We do not quite know whether the king at any time gave his blessing to this, or whether the archbishops were so strong that they did exactly what they themselves wanted. We are fairly confident that the king was not otherwise specifically concerned with the Norwegian coins. At that time, the big production was in Denmark,” says Risvaag.

Out in the world, both historians and metallurgists are following the research about the small coin workshop in the far north with great interest. The Royal Norwegian Society for Sciences and Letters has published an English-language book about the work called *The Mint in the Nidaros Archbishop´s Palace. Coin production under Archbishop Gaute Ivarsson (1475-1510).* ■

**A coin workshop in the mid 1500s, as is shown in the Swedish-Italian archbishop Olaus Magnus's great work, “History of the Nordic peoples” (1555).**

**Otto Lohne is a metallurgist and works at NTNU. He and colleage Pål Ulseth have reconstructed the entire time consuming process of minting medieval coins.**

## HOW COINS WERE MADE

**ANALYSIS: Chemical analysis was conducted in small bowls, called cupels, made of bone ash. A sample of material containing silver was weighed and melted together with lead in the cupel. Warm air oxidizes lead, but not silver, and at 900 °C, the molten lead oxide will remove the oxide from any other metals. Lead oxides and impurities enter the porous bone ash, so that only pure silver remains. When this is weighed, it is possible to calculate the silver content of the original object. Many cupels were found in the Archbishop's Palace coin workshop.**

**THE MELT: Materials containing copper and silver were melted in crucibles in a ratio of 30 per cent silver and the remainder copper, in accordance with the law. The hearth could have been covered with charcoal, because bits of carbon have been found in the hammered rods.**

**CASTING: Researchers are uncertain whether the coin metal was cast in sand or stone moulds. They believe most of the casting was done in sand, since stone moulds were not found the workshop. The metal was cast as rectangular or round bars with a cross-sectional area of about 30 mm$^2$.**

**FORMING: The rods were heated up and then flattened on an anvil. They were then cut into squares with a large pair of scissors. The corners were cut, and coin pieces were weighed and adjusted. They were then hammered flat before they were probably put in a stack in a kind of vice and hammered round in what were called blanks (forms). Afterwards, they were heated until they were malleable.**

**“WHITEWASHING”: The coin blanks were black and ugly, and were therefore “whitewashed” in a warm, acidic solution. The copper and copper oxide on the surface were thus dissolved. And when the minter hammered on the blank, pure silver was spread out over the surface in an even layer. This is the origin of the phrase “bright as a newly minted penny”.**

**EMBOSSING: The coin blank was put between two engraved dies and embossed with a sharp hammer blow. The top die was hand held. The bottom die was a cone-shaped piece of iron attached to an anvil on the end of a piece of wood. The top die wore out first and had to be replaced before the bottom die. A numismatist can use the differences in the times between when the top and bottom die were replaced to follow and date a series of coins for a long time.**

Photo: Bruce Sampson and Linn Ekle, NTNU Museum of Natural History and Archaeology

# Into the mist

About 40 million people worldwide have dementia, and many more will continue to be diagnosed in the future. How should society meet this challenge?

By Synnøve Ressem

Inger Anne Ree Hunderi (1942–2009) was diagnosed with dementia at age 55 and painted throughout much of the course of her disease. This image was made shortly after the diagnosis was made. (From "Into the Home of the Mist" by Inger Anne Ree Hunderi and Ola Hunderi.)

**THE FACTS:** Every year, 9 000 Norwegians are diagnosed with dementia. Sixty per cent of them have Alzheimer's disease. Many older people are never assessed for dementia, so the real numbers may actually be higher. The Norwegian health care system has relatively limited numbers of geriatric specialists. At the same time, the ageing population and the need for physicians with knowledge about dementia and complex age-related illnesses will increase dramatically in the coming years. Dementia generally cannot be cured.

Dementia is increasing dramatically around the globe and could soon be the most widespread and serious disease afflicting the global population. At the same time, researchers are racing to better understand the disease and find more effective drugs and treatments.

"If we can delay onset by just five years, the number of people with dementia may be cut in half, based on figures from the Karolinska Institute in Sweden. The prevalence of dementia increases significantly after the age of 80. Many people will not live long enough to develop the disease," says **Ingvild Saltvedt**, who teaches and conducts research on dementia at NTNU's Faculty of Medicine.

In the meantime, people with dementia require considerable help and nursing care. But perhaps we should start rethinking every aspect of care for those with dementia. Should we consider dementia a disability that is due to an illness, in line with other chronic diseases and disabilities, which would give patients rights to individual treatment, appropriate aids and special arrangements?

**A DREADED DIAGNOSIS** • "Dementia is an unwanted and dreaded diagnosis for which we should have the greatest respect. It means a change in one's overall life, as well as changes in everyday life – at first gradually, but eventually radically. It can be a daunting and sometimes lonely life. But it is not as grim as it is often portrayed. Many people live a long time with moderate cognitive changes, or find creative solutions to everyday challenges, and live well with the disease for many years. Some people put an emphasis on expression, joy and positive interactions in a more deliberate way than before their diagnosis. Some concede that their intellectual abilities are not what they once were, but at the same time can say that they have never thrived as much before they became ill. Much depends on how the individual handles the disease, and how the world relates to dementia," says **Kjersti Wogn-Henriksen**.

Wogn-Henriksen is a psychologist at Molde Hospital, and has extensive experience working with dementia patients. She is now working on a PhD at NTNU, which addresses dementia patients' self-understanding and insight into their own illness.

The study has a clear patient's perspective and will highlight what it means to live with dementia:

How do patients understand and experience their own illness? How do they try to live with the disease? What types of coping strategies do they choose?

The psychologist has closely followed a group of people with dementia over the past four years, and has studied how they have grown and changed with respect to the disease.

**MOST PEOPLE KNOW** • "I see that there are large individual differences. But most people seem to understand and accept that they have dementia. The challenge is to acknowledge that you have the disease and comprehend what that means, while at the same time, within certain limits, to create as rich a life as possible. Even though an individual may have problems related to dementia in some areas, that person can also be competent in other areas. An increasing number are happy to go hiking. One person loves fiction and enjoys reading, although she immediately forgets what she has read. Most say they manage to take one day at a time; they don't get obsessed about the future, and are good at emphasizing the positive. Some say they experience a phenomenon we see in others with serious diseases: they are reminded of what is important in life," says Wogn-Henriksen.

She adds that the people who are the happiest are those who are active and adaptable, have something with which to occupy themselves, and have managed to come to terms with new ways of existing in the world. They are not passive victims of their disease, but show a great willingness to learn and an ability to adapt. And it's not just a matter of an individual taking steps to live with dementia, but also relationship-based coping, where interactions with one's spouse, family or professionals are important.

The study also shows that there are gender differences:

"It appears that women are more likely to adapt to and cope with their new lives. In nursing homes, we see that women want to join around a table and enjoy each other's company. The men keep more to themselves. Women always have some little hobby that they can occupy themselves with, while it may be more difficult to motivate men.

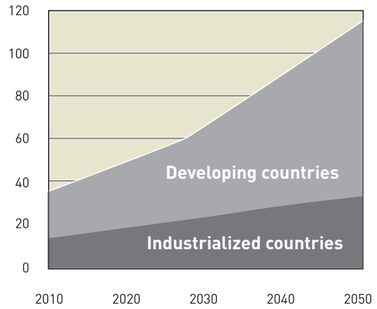
The difference may be because men, to a much greater degree than women, place emphasis on the ability to perform, to be self-assertive and independent," she notes.

Photo: Scanpix Denmark

## A FRIGHTENING DIAGNOSIS

Dementia is a catchall term for many brain diseases, the most common of which are Alzheimer's disease, vascular dementia, frontotemporal dementia and Lewy Body dementia. The largest group is comprised of those with Alzheimer's disease (60 %). The second largest group is vascular dementia, caused by poor blood flow due to blood clots in the brain or widespread atherosclerosis.

Source: Wikipedia




## GLOOMY FORECASTS

The graph shows the expected increase in the worldwide number of those with dementia. Today, about 40 million people are diagnosed with dementia, but that number could rise to 120 million by 2050. The trend is increasing, as the population gets older. Accordingly, the largest and most dramatic increase in dementia is found in developing countries, as lifespans increase.

Source: Alzheimer's Disease International

**FINDINGS FROM THE FREEZER** • But why and how is the brain damaged in dementia – what goes so terribly wrong? So far, virtually every new discovery related to the disease has led to more questions than answers.

A huge warehouse at the HUNT Biobank in Levanger is jam-packed with freezers holding blood samples and DNA material from thousands of residents of the county of Nord-Trøndelag, north of Trondheim. This material is used in medical research in many areas. Perhaps there are secrets frozen here that could solve some of the many mysteries surrounding dementia?

In addition to biological material, there are MRI images of the brains of Nord-Trøndelag residents, and a whole host of other information about their health-related conditions.

HUNT (*the Nord-Trøndelag Health Study*) has been undertaken in three separate surveys over eleven years. The first was conducted in 1984–1986. Some of the participants in that first survey have now reached an age where they are at risk of developing dementia. This means that it is possible to find detailed health data for people who develop dementia fully 20 to 30 years before they show signs of the disease.

"We are now in the process of building a database where we assemble all of the information we have about participants who have received a diagnosis of dementia," says **Jostein Holmen**, a professor at NTNU's Department of Public Health and General Practice and until recently, director of HUNT.

"This dementia database makes it possible to compare all of the health-related information and material that we have for these patients. It can show whether there was anything special about them before they developed dementia. This is unique and can be a goldmine for researchers. We are not aware of any database like it in the world," says Holmen.

Currently, the database includes people who have been assessed and have been diagnosed by a specialist in the last 15 years. The Health and Memory project involves collecting data from people who have been referred for assessment at the memory clinic, and patients with dementia in every nursing home in Nord-Trøndelag. Linking the results from these studies to data from HUNT provides unprecedented opportunities to identify early risk factors, different types of dementia, and additional symptoms of dementia, such as psychosis, depression and agitation.

The broad survey also provides valuable information about the prevalence of dementia, medication use, functional status, quality of life and physical illness among nursing home residents in Nord-Trøndelag.

The project has been undertaken in cooperation with the Norwegian Centre for Research, Education and Service Development Centre, Ageing and Health, among others. In the next round, Holmen wants to include the elderly living at home. The purpose is clear:

"We know that the number of elderly will increase, and we must prepare ourselves for it. We need to gather as much information as possible, and ensure that we create the capacity to address this situation in health personnel at all levels – especially in doctors," says Holmen.

In his opinion, modern medicine is unilaterally focused on curing people, and is too unconcerned with relieving pain and providing care.

"We forget that providing care and relief from pain is the original humanistic tradition in medical science, and was prominent until the Second World War. Alzheimer's is among the diseases that we cannot cure. It must be treated with other approaches and requires that doctors change their attitudes and give more of themselves," says Holmen.

**DEMENTIA AND DEPRESSION** • One of the individuals working with the dementia database is **Eystein Stordal** – who is also one of Norway's few specialists in geriatric psychiatry. He believes that the database is a valuable source of new knowledge about the causes and risk factors for dementia, and believes that many disorders may predispose an individual to dementia.

"We already suspect that some of these illnesses are different types of what we call lifestyle diseases," says Stordal.

For his part, Stordal will use health data from HUNT to conduct research on dementia and depression.

"During the early stages of dementia, the clinical picture is quite complex, and is challenging to diagnose. Often we have to address several diseases that occur at the same time – there may be a mix of problems, including cognitive impairment, and psychological and physical symptoms," he says.

The main problems that are present in geriatric disease are dementia and depression, both of which occur at high rates and share very similar symptoms. This means that the symptoms are easy to misinterpret. "This is unfortunate for several reasons. Dementia cannot be cured, but depression can be treated. We have both effective drugs and other treatments for depression," Stordal says.

He adds that some brain studies of chronic

Photo: photos.com

## RESEARCH DREAM

Dementia cannot currently be cured, but an intense research race is underway to develop drugs that can prevent and delay its development and reduce symptoms.

depression and Alzheimer's dementia show changes in the same brain area.

**NEW DIAGNOSTIC TOOLS** • Sigrid Botne Sando is a senior consultant at St. Olav's Hospital, and a postdoctoral fellow at NTNU's Department of Neuroscience. Her area of research specialization is dementia in general, specifically Alzheimer's disease.

In connection with her doctoral work in 2008, "Alzheimer's Disease in Central Norway: Genetic and Educational Aspects," a biobank was established of blood samples from 600 Trøndelag-area residents with dementia and about as many healthy, older residents from the same region. The project is called Tronderbrain.

Sando and her research group used the material to study a well-known genetic risk factor for Alzheimer's disease, *APOEε4*.

*APOE* is a gene carried by everyone, and comes in several variations, called *alleles*. The most common variants are called *ε2*, *ε3* and *ε4*.

Photo: Wikipedia

## DISCOVERER

Alois Alzheimer (1864–1915), a German physician, psychiatrist, neurologist and neuropathologist, was the first to identify the symptoms and the histological findings of what is now known as Alzheimer's disease. He observed the disease in a patient in 1901. When she died five years later, Alzheimer examined her brain and found distinctive changes.

Everyone has two alleles, one of which is inherited from his or her mother and the other from his or her father. All combinations are possible. The *APOEε4* allele increases the risk of developing Alzheimer's disease, with the risk even higher if you have inherited *APOEε4* alleles from both parents. However, it is not necessary or sufficient to not have the *APOEε4* allele to develop Alzheimer's disease.

Sando's investigation of this genetic risk factor is the largest ever conducted in the Nordic countries. She found that the risk of developing Alzheimer's disease increases by a factor of 4.3 if you have one of the risk-related alleles.

If an individual has inherited a double dose of the *ε4* allele, i.e. from both parents, that person is about 13 times more likely to develop the disease as individuals without the variant at all. This is consistent with findings in similar populations elsewhere in the world.

**EDUCATION HELPS** • In her doctoral thesis, Sando also examined the Tronderbrain material to see how education and schooling related to the development of Alzheimer's disease. International studies have shown that the risk of Alzheimer's is higher in populations with little education. Sando also found that there was a correlation between the risk of Alzheimer's and the number of years in school. The more education – the lower the risk.

"In other words, it looks like it is good to use the brain, just like muscles. One explanation is that education/use of the brain may contribute to the formation of new synapses (connections between nerve cells), so that the brain has 'more to go on' when the disease strikes. Other studies have also shown that physical activity reduces risk with respect to Alzheimer's disease," says Sando.

She is now a postdoctoral researcher, work- ing again with the collection of material from Trondheim-area patients who have mild cognitive impairment and patients with early-stage Alzheimer's disease, as well as from healthy, same-aged control subjects. Both blood and cerebrospinal fluid from patients and control subjects have been collected.

"The main purpose of the project is to look at biological markers for Alzheimer's disease. Biological markers (biomarkers) can be used in diagnosis, in developing a prognosis and to assess the efficacy of drug therapy. When we have more effective treatments for Alzheimer's disease, it will be important to be able to make the correct diagnosis at an early stage of the disease so that treatment can be started as early as possible," said Sando.

The collection of biological material will extend until 2014, but the analysis of the material is likely to continue beyond that date.

**THE RACE TO FIND ANSWERS** • Researchers have also identified two proteins, amyloid and tau, which are involved in the process of destroying the brain.

The proteins clump together and create insoluble tangles, which first create errors in the biochemical signal transmission between nerve cells and subsequently lead to cell death.

Researchers at NTNU's Department of Physics are conducting on-going experiments that should help clarify the processes that take place in the brain. In cooperation with Linköping University, Professor **Mikael Lindgren** has developed custom-designed molecules, called probes, which can be sent into the brain through the blood stream and literally light up what goes on inside there. A previous article in Gemini about Lindgren's work, called *Light in the Darkness*, was published in September 2008.

In short, the mission for the probe is to recognize the special structures of proteins that destroy brain cells in Alzheimer's dementia. The proteins are associated with various stages of the destruction process. When the probe enters the brain, it will look for the different proteins and attach to them.

The probe's journey towards its goal can be followed using a laser light. Once it has attached itself to the protein that it has been looking for, the laser light changes colour. The different colours tell researchers which proteins are found in the brain, so they can determine how advanced the disease is.

"We have made great strides since the last time you wrote about the project," Lindgren tells Gemini. "When we last spoke, we had managed to make just two probes, but now we have 15. This means that we can find 15 different protein structures. We have also succeeded in making fluorescent probes and magnetic probes. This means that the probes can be imaged using MRI, which provides completely new opportunities."

Lindgren hopes that the probes and the technology behind them can be used as a diagnostic tool for different stages of Alzheimer's. Then it may be possible to detect the disease at an early stage.

"We are much closer to a tool that can be used on humans. Currently, we have experimented with mice," he says.

**CONFUSION IN THE ARCHIVE** • Lindgren is planning to work with **Menno Witter**, a professor of neuroanatomy and a scientist at NTNU's Centre for the Biology of Memory, about possible applications for the probes. The centre collaborates with researchers around the world to understand the brain region called the hippocampus, which is involved in memory and learning. Several types of dementia begin in this area.

Understanding what is going on in a healthy brain is a prerequisite for understanding pathological conditions. Witter's project concerns the changes taking place at the very beginning of the long process leading to Alzheimer's disease, and understanding how the memory network works.

Photo: City of Bergen / Bernt A. Tungodden

## GARDEN FOR HEALTH AND WELL-BEING

A sensory garden for those with dementia has been designed and adapted specifically for this patient group's needs. The garden is often linked to a day-care centre or nursing home, and aids residents by stimulating all their senses. The Norwegian National Centre for Ageing and Health has established eight test gardens across the country.

He explains that the hippocampus acts as an information centre, which receives information from sensory inputs and sends it further around the brain, where it is stored as memories.

"We can imagine that the brain is like a filing cabinet, which has separate drawers for pictures, taste, smell and hearing – all the elements we need to form a complete memory of an experience," Witter says.

All of the file drawers are related to each other, he explains. The memory of an image can be turned on and awakened by the perception of a voice, a melody or a smell. If we pull out a tray for smells and think of the memory of the scent of a rose, it may be associated with other impressions that were stored at the same time, which would call up the memory of a certain garden party, for example.

"To recall the memory of this interview, it may be enough for you to simply hear the sound of my voice. But to remember the whole thing, you have to call up a great deal of information about the details: how did I look, what did I wear, what did the room look like, how we were positioned in the room and so on," Witter says.

One of the earliest symptoms of Alzheimer's is the inability to store new memories, and that similar memories interfere with each other and blend together. This is seen in the hippocampus and the adjacent paracampus.

Something goes wrong in the network that connects the different brain areas and the various "file drawers" with each other. The problem causes the network to collapse like a house of cards, but why? In order to store new memories the brain must reorganize itself. Is this the process in adults that can cause someone to develop dementia? This is one of the questions that Witter hopes to answer.

**MEDITATION AND GREY MATTER** • Dementia research takes many different approaches, and new discoveries add new pieces to the puzzle. For example, a recent study from the University of Tromsø suggests that there may be a connection between dental health and the development of dementia. Other theories have not come farther than the thinking stage. For example, there is some speculation as to whether meditation can have a preventive effect on dementia.

"It has not been possible to find any direct evidence that meditation provides a dampening or braking effect on the development of dementia," says **Are Holen**. He is a professor of psychiatry at NTNU and founder of the Acem organization for meditation.

However, there are numerous studies that show that the thickness of grey matter in the brain increases in those who meditate. The change can be seen after a short time. Even after eight weeks, it has been demonstrated that parts of the brain are thickened in those who have begun to meditate.

It has also been shown that the thickness increases relatively more in the elderly than in younger individuals.

The age-related reduction in the thickness of grey matter is less in those who meditate, in some parts of the brain. The parts of the brain where these changes take place are central in the development of dementia.

"That means it is possible to assume that meditation can reduce or stop dementia, but it has not been proven that it really does so. But the findings are interesting and may point in that direction," says Holen.

**THE IMPORTANCE OF OLFACTION** • PhD candidate **Grete Kjelvik** at the Department of Circulation and Medical Imaging studies how olfactory stimulation affects activation patterns in the brain. The method she uses is called functional MRI (fMRI), and her study includes patients recruited from the geriatric outpatient clinic at St. Olavs Hospital, as well as healthy elderly control subjects.

In an fMRI investigation, the brain is ima-

ged while the subject is inside the MRI machine and is performing a task – in this case, a task related to the sense of olfaction.

"In this way, we can see where there is activity in the brain while the subject smells something," explains Kjelvik.

Kjelvik is examining the fMRI images that are generated from the patient groups while they use their sense of smell, to see if there are differences from the healthy control group.

"There are areas in the temporal parts of the brain that are activated by olfactory stimulation, and the degenerative process in Alzheimer's disease is thought to start in the structures of the temporal lobe. A number of international studies have shown that Alzheimer's is associated with hyposmia, an impaired sense of smell. In this way, the link between olfaction and memory is very interesting," says Kjelvik.

**INTO THE MIST** • Not so very long ago, dementia was surrounded by taboos and shame, and was something you would rather not talk about. The taboos are still there, but are lessening as people learn more about the illness. In the past there have been efforts to educate the public, both by officials and by private individuals.

A leader in this area is Ola Hunderi, a physics professor at NTNU.

*"Seeing a loved one slowly melt away from you is not easy. It weighs you down with a grief that is impossible to describe. She's still here! "*

The quotation is taken from "Into the Home of the Mist", the book Hunderi has written about life with his wife Inger Anne, who as a 55-year-old was diagnosed with Alzheimer's. Here he describes candidly the insidious symptoms at the start and her slow evolution into becoming fully dependent on others.

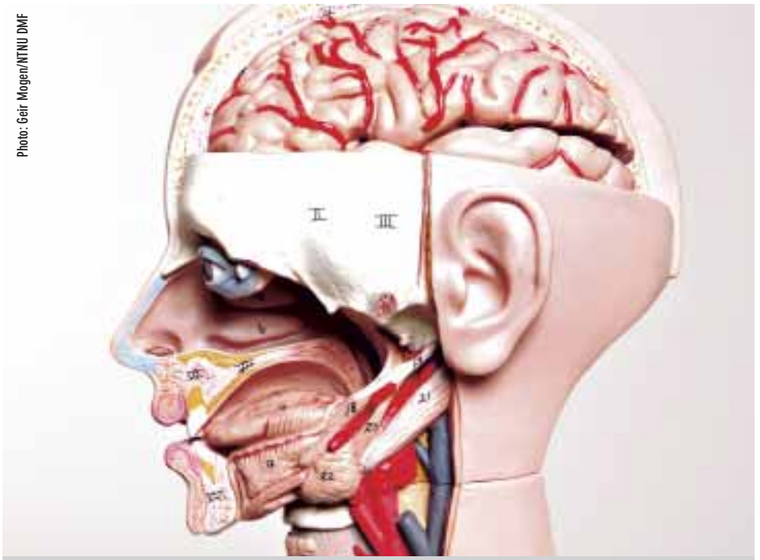
"All her ability to communicate and move was gone. The last form of contact was through her eyes. In rare and brief glimpses, I was convinced that there was someone in there. No one can know how the patient experiences this phase. I speculate that dementia may not be the worst end of life ... Maybe it is worse to die of cancer with excruciating physical pain," Hunderi says.

The resourceful professor was able to take on his wife's care until late in the disease. When his wife finally got a place in a nursing care facility, he moved into the same room.

"It was a win-win situation for both us and the health professionals," he says. "For Inger Anne, it made the move less dramatic, and she felt safer having me there. Despite the circumstances it helped to normalize my life. I could do my work and could do things more freely, without fear of what might happen at home. I was assured that she was in good hands. And the nursing staff got welcome relief."

Hunderi is upset that most media stories about caring for those with dementia are horror stories and descriptions of abject misery. "I was witness to an impressive effort that gave me an insight I never will forget," he says about the experience.

Photo: Geir Mogen/NTNU DMF



## WHY THINGS GO WRONG

NTNU's Centre for the Biology of Memory is working to understand the hippocampus, the region of the brain that is involved in memory and learning. All types of dementia start in this area. One of the earliest symptoms of Alzheimer's is the inability to store new memories, and a problem with similar memories interfering with each other and blending together. This occurs in the hippocampus and the adjacent paracampus.

**PSYCHOLOGICAL PRESSURES** • Inger Anne Hunderi had what is called early onset Alzheimer's. Its symptoms are similar to the more common version of Alzheimer's, which occurs in the elderly, but the disease can sometimes progress much faster.

Early onset Alzheimer's represents a relatively small category of dementia-related diseases. Yet it is this variation that we hear and read most about. It may be because resourceful individuals like Hunderi stand up and share their personal experiences. He travels far and wide to give talks and is always willing when someone wants him as a speaker.

In his book he makes it clear that it is not only the patient who is affected by a diagnosis of dementia. Life also changes radically for any partners.

That fact is important, because more than half of all elderly patients with dementia live at home, and that figure is expected to rise. Most people want to live at home as long as possible.

This aspect of dementia care is largely unexplored, and there is little literature on the subject.

Bente Nordtug is a nurse specializing in dementia disorders who defended her PhD in June 2011 at NTNU's Department of Neuroscience. She studies the burden of care for the one partner when the other partner gets dementia and continues to live at home. As far as she knows, no one has done similar studies in Norway.

Nordtug has come up with several sobering findings – among other things, that 60 per cent of the people who live with individuals with dementia have a high incidence of psychiatric symptoms.

"If they had been examined by a psychiatrist, they would have been given one or more diagnoses," Nordtug says.

Her investigation includes different stages of the dementia process. She has found that the impact is relatively modest at first, but increases rapidly as the disease worsens. The less self-reliant the ill person is, the greater the impact.

"In cases where the dementia is aggressive, the burden of care is even greater. There is much to suggest that affected families reach far, often *too* far, in trying to offer care, and that they look for nursing home places too late," she says. "This is unfortunate for several reasons. First, because there are long waiting lists and it is hard to get a place. This increases the wear on the caregiver, who is already exhausted. And patients with more advanced cases of the disease find it harder to adjust to the new surroundings."

**GENDER AND CARE** • The study shows interesting gender differences in what affects the burden of care among relatives.

"It seems that men put most emphasis on the need for breaks, with time for themselves. It means a lot to them that their partner can be left alone for a number of hours, or that he gets help, and a break from having to provide care. But uninvited help is experienced paradoxically as a burden. The men in the survey want to ask for help themselves, and want have control over the situation. Even if friends and family pull away, this has little impact on the burden of care for men," says Nordtug.

She finds that the picture is quite different for women. Women find it difficult that family, friends and neighbours keep their distance. This type of withdrawal is common. It may be due to the fact that dementia carries a stigma, but also due to the fact that close friends and family simply do not know how to cope, what to say and how they can be of help.

"Women talk a lot about the loss of having someone to discuss things with, to hug, share feelings with, to do things with. They want a response to their emotional reactions and see this as positive," says Nordtug.

"The women's approach is to ask 'How do *you* do that?' They are out there, finding out what works well and what doesn't, reflecting on why things work and are constantly evaluating the situation. They have a wait-and-see attitude, and try to fend for themselves as long as possible. It is common for women to wait longer than men in similar situations to seek a place in a nursing home or care facility," she says.

It would seem that Nordtug's findings reflect traditional gender role patterns: women react emotionally, men are more rational. This may be one explanation for why men seem to get help more quickly from the system of care when they ask for it.

Nordtug believes that the strengths and weaknesses of the gender differences she has found should be exploited in a positive way: "The conclusion is that family members who provide care are an important group to educate and support, and that this should also be emphasized in the training of health care workers."

**TECHNOLOGY FOR DEMENTIA** • Many believe that new technologies will give people with dementia a better life. Others are afraid that technology could be used as a crutch and will reduce patient access to human contact and care.

One of the most difficult discussions centres on equipping people with dementia with tracking tools such as GPS. Sceptics frame the discussion around ethical issues, and are concerned about privacy, among other issues. Supporters believe that it is more important that GPS can give people with dementia greater security and a better quality of life, because they will be able to move more freely.

SINTEF is involved in several projects related to technological aids for people with dementia. One of them relates to social media. The project has as its starting point the fact that social media are playing an increasingly important role in modern society. Social media are important venues for social contact and communication. This creates new opportunities for how we interact socially.

Older people with dementia are groups that traditionally have not used computers and social media. By customizing and adapting the technology, it may also be possible for this group to use social media.

A project called *Alma's House* is designed to examine how assistive technology and well-being technology can be integrated into a larger holistic programme of care for people with dementia. This research is being conducted in collaboration with the municipalities of Drammen, Bærum and Oslo, along with Livework Nordic AS.

A pilot project will be launched in 2011 in partnership with the City of Oslo, SINTEF, the National Centre for Ageing and Health, the Oslo University Hospital and the Department of Computer Science at the University of Oslo.

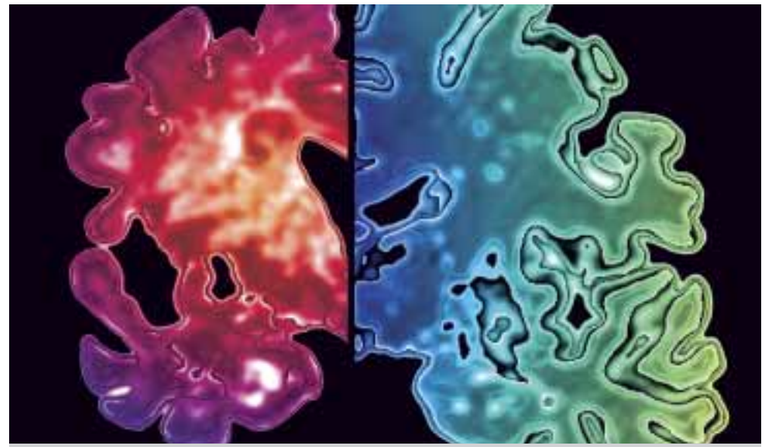


Photo: Science Photo Library/Scanpix

## CELL KILLERS

Two proteins, amyloid and tau, work together in Alzheimer's disease to destroy the brain. The proteins clump together and create insoluble tangles. This creates errors in the biochemical signal transmission between nerve cells, and subsequently leads to cell death.

**SOMEONE WHO CARES** • Psychologist Kjersti Wogn-Henriksen is a strong advocate in arguing that society must open up and become more inclusive and generous to people with dementia. This would make it easier both for those who are ill as well as their relatives.

Experience suggests that quality of life increases with the degree of openness.

"Those who are able to talk openly about what it is like, gain more space in which to live and move. But it is not always easy in a society that values the ability to be quick and dynamic and intellectually productive," says Wogn-Henriksen. "The opposite approach is to try to keep the illness hidden and struggle to live life the same as before. For these people, the feeling of powerlessness must be great, and I fear they live a lonely life."

The psychologist hopes that her PhD thesis will help to shake up some old prejudices and provide a more nuanced view of dementia as more than just an assemblage of deficiencies.

"There is a real need to change attitudes, based on knowledge and understanding and a willingness to see the individuals behind the dementia. And we have to have a different perspective on care. What is forgotten is uninteresting. What is important is what is remembered, what is still perceived as meaningful, and if there is someone who cares," she says. "To have dementia is not the same as ceasing to live as a human being." ■